Roll No. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. /B. Tech (Full Time) - SEMESTER ARREAR EXAMINATIONS, APR / MAY 2024

Mechanical Engineering
Fifth semester
ME 5551 & Design of Machine Elements
(Regulation 2019)

Time:3 hrs | Max. Marks: 100

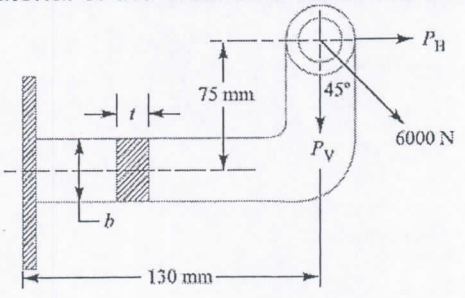
CO1	Designing machine members subjected to static and variable loads.
CO2	Designing shafts and couplings for various applications.
CO3	Analyzing bolted and welded joints for various kinds of loads.
CO4	Designing helical, leaf springs and flywheels for various applications
CO5	Designing and select sliding and rolling contact bearings.

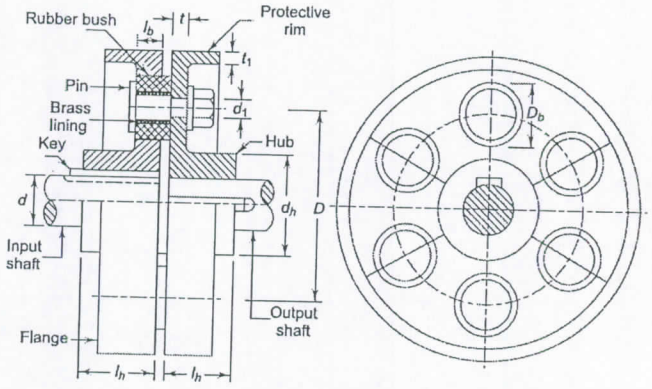
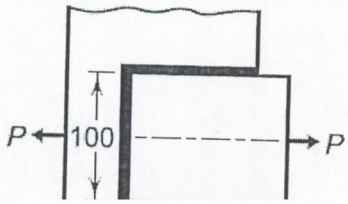
BL – Bloom's Taxonomy Levels
(L1-Remembering, L2-Understanding, L3-Applying, L4-Analysing, L5-Evaluating, L6-Creating)

PART- A (10x2=20Marks)
(Answer all Questions)

Q. No.	Questions	Marks	CO	BL
1	State the maximum principal stress theory.	2	1	L1
2	What is meant by fatigue?	2	1	L2
3	What are the properties that a shaft material should possess?	2	2	L1
4	What are splined shafts?	2	2	L2
5	State the drawback of screwed joints.	2	3	L2
6	What is a lap weld joint?	2	3	L1
7	What type of stresses are induced in a flywheel rim?	2	4	L2
8	What is a disc spring?	2	4	L1
9	Classify bearings based on the nature of contact.	2	5	L1
10	What for self-aligning bearings used?	2	5	L2

PART- B (5x 13=65Marks)
(Restrict to a maximum of 2 subdivisions)

Q. No.	Questions	Marks	CO	BL
11 (a)	A mild steel bracket as shown in Fig. 11a, is subjected to a pull of 6000 N acting at 45° to its horizontal axis. The bracket has a rectangular section whose depth is twice the thickness. Find the cross-sectional dimensions of the bracket, if the permissible stress in the material of the bracket is limited to 60 MPa.  Fig. 11 a	13	1	L 3 & L5
	OR			

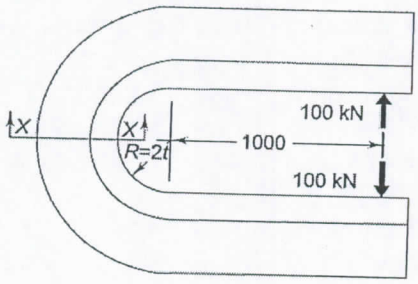
	the rod using a factor of safety of 2 for an infinite life condition.			
12 (a)	A shaft is supported by two bearings placed 1 m apart. A 600 mm diameter pulley is mounted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 2.25 kN. Another pulley 400 mm diameter is placed 200 mm to the left of right hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulleys is 180° and $\mu = 0.24$. Determine the suitable diameter for a solid shaft, allowing working stress of 63 MPa in tension and 42 MPa in shear for the material of shaft. Assume that the torque on one pulley is equal to that on the other pulley.	**13**	**2**	**L 4 & L5**
	OR			
12 (b)	A flexible coupling, illustrated in Fig. 12b, is used to transmit 15 kW power at 100 rpm. There are six pins and their pitch circle diameter is 200 mm. The effective length of the bush (l_b), the gap between two flanges and the length of the pin in contact with the right-hand flange are 35, 5 and 23 mm respectively. The permissible shear and bending stresses for the pin are 35 and 152 N/mm^2 respectively. Calculate the pin diameter by shear consideration; and the pin diameter by bending consideration.  **Fig. 12 b**	**13**	**2**	**L 4 & L5**
13 (a)	Design a double riveted butt joint with two cover plates for the longitudinal seam of a boiler shell 1.5 m in diameter subjected to a steam pressure of 0.95 N/mm^2. Assume joint efficiency as 75%, allowable tensile stress in the plate 90 MPa, compressive stress 140 MPa and shear stress in the rivet 56 MPa.	**13**	**3**	**L 4 & L5**
	OR			
13 (b)	A steel plate, 100 mm wide and 10 mm thick, is joined with another steel plate by means of single transverse and double parallel fillet welds, as shown in Fig. 13 b. The strength of the welded joint should be equal to the strength of the plates to be joined. The permissible tensile and shear stresses for the weld material and the plates are 70 and 50 N/mm^2 respectively. Find the length of each parallel fillet weld. Assume the tensile force acting on the plates as static.  	**13**	**3**	**L 4 & L5**

14 (a)	A semi-elliptic multi-leaf spring is used for the suspension of the rear axle of a truck. It consists of two extra full-length leaves and ten graduated-length leaves including the master leaf. The centre-to-centre distance between the spring eyes is 1.2 m. The leaves are made of steel 55Si2Mo90 (S_{yt} = 1500 N/mm^2 and E = 207000 N/mm^2) and the factor of safety is 2.5. The spring is to be designed for a maximum force of 30 kN. The leaves are pre-stressed so as to equalize stresses in all leaves. Determine the cross-section of leaves; and the deflection at the end of the spring.	**13**	**4**	**L 3 & L5**
	OR			
14 (b)	A single cylinder double acting steam engine develops 150 kW at a mean speed of 80 rpm. The coefficient of fluctuation of energy is 0.1 and the fluctuation of speed is ± 2% of mean speed. If the mean diameter of the flywheel rim is 2 m and the hub and spokes provide 5 percent of the rotational inertia of the wheel, find the mass of the flywheel and cross-sectional area of the rim. Assume the density of the flywheel material (which is cast iron) as 7200 kg/m^3.	**13**	**4**	**L 3 & L5**
15 (a)	A full journal bearing of 50 mm diameter and 100 mm long has a bearing pressure of 1.4 N/mm^2. The speed of the journal is 900 rpm. and the ratio of journal diameter to the diametral clearance is 1000. The bearing is lubricated with oil whose absolute viscosity at the operating temperature of 75°C may be taken as 0.011 kg/m-s. The room temperature is 35°C. Find the amount of artificial cooling required, and the mass of the lubricating oil required, if the difference between the outlet and inlet temperature of the oil is 10°C. Take specific heat of the oil as 1850 J / kg / °C.	**13**	**5**	**L 4 & L5**
	OR			
15 (b)	A single-row deep groove ball bearing is subjected to a radial force of 8 kN and a thrust force of 3 kN. The shaft rotates at 1200 rpm. The expected life L10h of the bearing is 20000 h. The minimum acceptable diameter of the shaft is 75 mm. Select a suitable ball bearing for this application.	**13**	**5**	**L 4 & L5**

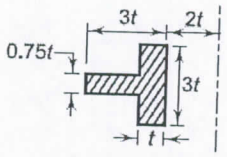
PART- C (1x 15=15Marks)

(Q.No.16 is compulsory)

Q. No.	Questions	Marks	CO	BL
16.	The C-frame of a 100 kN capacity press is shown in Fig. 16. The material of the frame is grey cast iron FG 200 and the factor of safety is 3. Determine the dimensions of the frame.	**15**	**1**	**L 4 & L5**



(a)



(b) Section at *XX*

Fig. 16

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